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CASE REPORT

# RETURN TO ADVANCED STRENGTH TRAINING AND WEIGHTLIFTING IN AN ATHLETE POST-LUMBAR DISCECTOMY UTILIZING PAIN NEUROSCIENCE EDUCATION AND PROPER PROGRESSION: RESIDENT'S CASE REPORT

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## ABSTRACT

***Study Design:*** Case Report

***Background and Purpose:*** The use of pain neuroscience education (PNE) is indicated when there are psychosocial contributions to a person's pain experience. The scientific literature has established the efficacy of the use of PNE in a population with chronic pain but there is a paucity of evidence to support the use of PNE in athletic populations. The purpose of this case report is to describe the use of PNE and graded exposure exercises specific to an athlete returning to Olympic weightlifting.

***Case Description:*** The patient underwent an L5-S1 discectomy to resolve paresthesia in his leg, completed a bout of post-operative rehabilitation but returned 15 months after the surgery. He presented with the chief complaint of low back tightness and fear of lumbar flexion. When asked to touch his toes during the lumbar flexion range of motion examination, he demonstrated aberrant lumbar movement by hinging at the hips with a straight back due to fear that flexing would damage his lumbar spine. The patient was seen for four weeks with a focus on PNE and graded exposure to weightlifting activities.

***Outcomes:*** The patient returned to Olympic weightlifting and decreased his Fear Avoidance Behavior Questionnaire (FABQ) score from 22 to 4 during the course of physical therapy. His Tampa Scale of Kinesiophobia (TSK) score also decreased from 55 to 31. By discharge, he was able to bend at the lumbar spine with full flexion and no longer believed the motion to cause damage.

***Discussion:*** The case is unique because it describes the implementation of PNE in an athlete returning to weightlifting, and the scientific literature for use of PNE in this population is lacking. The identification of kinesiophobia and implementation of PNE and graded exposure exercises lead to an optimal outcome for this patient.

***Level of Evidence:*** Level 4

***Key Words:*** graded exposure, kinesiophobia, lumbar discectomy, movement system, pain neuroscience education, weightlifting

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## BACKGROUND AND PURPOSE

Treatment of patients with low back pain can be limited when a patient presents with psychosocial factors such as depression, anxiety, misconception of pain, and previous negative pain experience.[1,2] When using patient reported outcome measures such as the Roland-Morris Disability Questionnaire (RMDQ), Fear Avoidance Beliefs Questionnaire (FABQ), and McGill Pain Questionnaire (MPQ) with patients with low back pain, studies have shown that higher scores on the FABW, MPQ and RMDQ are more correlated with the aforementioned psychological factors than physical examination or imaging findings.[1,2]

The efficacy of using Pain Neuroscience Education (PNE) in the treatment of musculoskeletal pain in the general population has been well established in the scientific literature.[3] Physical therapy (PT) in conjunction with PNE can be effective at reducing pain and fear of movement in populations with chronic lower back pain.[3,4] More specifically, PNE has been successfully implemented in patients with complex regional pain syndrome, lower back pain, chronic lower back pain, and patients undergoing lumbar surgery.[4–6] Patient education sessions focusing on PNE involves teaching the patient how the nervous system processes pain using neurobiology and neurophysiology constructs.[7] The use of PNE is indicated when there are significant contributions from psychosocial factors in a person's pain experience such as depression, fear avoidance, previous injury, etc. The goal of PNE is to shift a person's understanding of pain as a sign of injury to more of an alarm system used for the body's protection.[8] Results from a recent systematic review of studies of patients with chronic low back pain indicate that PNE alone can decrease low back pain-related disability in the short-term, however PNE must be combined with other physiotherapy interventions such as exercise and manual therapy in order to maximize its effects on pain and disability.[4] Despite the supporting evidence for implementing PNE into clinical practice, there is little known about the application of PNE to an athletic population with fear avoidance behavior. Most athletes are used to receiving treatment based on the biomedical model[9] and could possibly display resistance against PNE interventions because of this expectation. In particular, Olympic weightlifters with low back pain may be at heightened risk of developing fear avoidance behavior due to the required coordination of the spine and lower extremities and loading demands of the spine with various weighted lifts such as cleans, deadlifts and squats.[9,10] Although evidence to the support the use of PNE and graded exposure techniques has been less established in the literature for athletes, rehabilitation professionals have been implementing this into practice for quite some time with athletes. One prime example is a rehabilitation professional who has to provide graded exposure, evidence based strengthening and neuromuscular control exercises, and encouragement to an athlete post anterior cruciate ligament reconstruction with fear avoidance behavior regarding return to sport.[11,12] Due to the demands placed on each and every bodily system in the athlete, they may require a biopsychosocial approach that is exceeds the needs of the general population.[9] Along with the PNE, the graded exposure would have a continuum that is related to the athletes sport rather than a daily activity they are having difficulty with.

Graded exposure exercise and activities have been used in conjunction with PNE. Graded exposure allows the patient to confront specific situations they may be fearful of in a gradual and non-threatening manner allowing a decrease in fear-avoidant behaviors. The patient can be gradually exposed to multiple situations including, but not limited to: Activities of Daily Living (ADL's), lumbar flexion, a wide variety of work tasks, or as seen in this case report, higher-level weightlifting. The available literature supports the use of graded exposure in patients with chronic low back pain, but little is known about the use of PNE after discectomy.[1] Preoperative PNE has been utilized for patients undergoing lumbar discectomy and has been shown to reduce healthcare costs, pain, and disability.[13] To the authors' knowledge, PNE utilization has not been studied post-operatively. The subject of this case report was not seen by the resident physical therapist immediately post-operatively, but received care that did not include PNE. During the 2nd bout of physical therapy, PNE was included in the plan of care by the resident physical therapist and offers valuable points to consider for post-operative care. Compared to pre-operative PNE utilization, the subject in this case report had held his beliefs about pain

for months and had done his own research regarding his condition which may have made it more difficult to educate the subject correctly. In addition to PNE, the integration of graded exposure into the treatment of musculoskeletal pain has the ability to decrease catastrophization, which is broadly defined as an exaggerated negative "mental set" that surfaces during an actual or anticipated pain experience,[14] in subjects with lower back pain. [15,16]

Applying graded exposure techniques to facilitate the return of an athlete to Olympic weightlifting should be guided by a linear periodization model that allows for a systematic and predictable method of progression while utilizing strength and conditioning principles in order to increase strength and power. Managing psychosocial factors in conjunction with orthopedic impairments in athletic populations is a challenge for sports physical therapists because of a lack of research to guide the decision making and implementation of PNE and graded exposure. Therefore, the purpose of this case report is to describe the use of PNE and graded exposure interventions specific to an elite athlete returning Olympic weightlifting.

## CASE DESCRIPTION: SUBJECT HISTORY

A 37-year old male presented to a primary care physician in 2016 with left-sided low back pain with radicular symptoms down the left posterior thigh and lower leg to the calf (Figure 1). The subject reported that the injury occurred during a barbell deadlift. Prior to consultation with the surgeon, a magnetic resonance imaging (MRI) was ordered by his primary care physician and confirmed a L5-S1 disc herniation. The subject did not receive PT before surgery, he had an appointment scheduled but did not attend. Given the physical exam findings of myotomal weakness, diminished reflexes, a positive straight leg raise and MRI results, the surgeon and subject agreed that surgery was the best course. A lumbar discectomy was performed in November of 2016 at L5-S1 with a S1 foraminotomy, hemilaminectomy and medial facetectomy. Subject stated, upon discharge the surgeon instructed the subject to follow up with PT in three to four weeks, and instructed the subject to "never return to Olympic weightlifting."

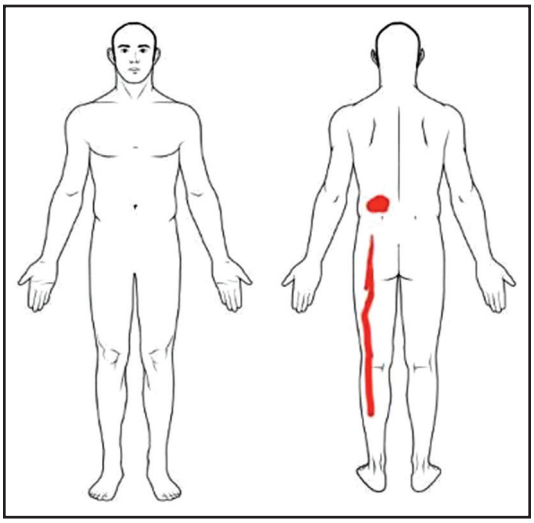

**Figure 1.** *The patient's body chart at the 1st physical therapy initial examination.*

Subsequently, the subject presented to an outpatient PT clinic approximately five weeks post-surgery. The subject's primary complaints were low back pain and radicular symptoms into buttock, whereas prior to surgery the symptoms radiated into the foot. The subject yielded a score of 20% on the Oswestry Disability Index (ODI). The ODI is comprised of 10 items scored from 0 to 5. Item scores are added and then divided by the total possible number of points (50) to calculate the overall score as a percentage from 0% to 100%. Higher scores signify greater disability. The ODI has demonstrated strong psychometric properties with a threshold of 50% improvement as a valid measure for defining success with a Minimally Clinical Important Difference (MCID) of 10%.[17,18]

Treatment was targeted at increasing range of motion, strength and function through the use of manual therapy and exercise directed towards the lumbar spine. The subject responded very positively to repeated lumbar extension and therapeutic exercise, which not only improved his range of motion but also his radicular symptoms into the buttock. The subject was discharged from PT with an ODI score of 6%, yielding a 14% score reduction from original ODI score and meeting the MCID of 10%.

One year after completing postoperative rehabilitation and a total of 19 months after surgery the subject presented to PT, to the same physical therapist

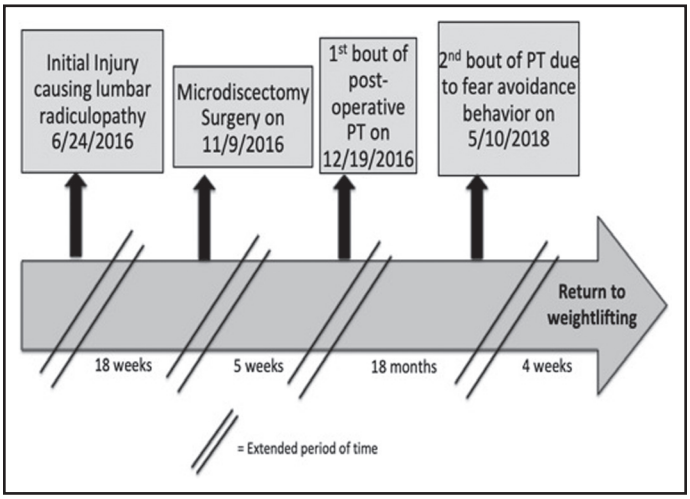


**Figure 2.** *Chronology of events.*

and PT resident, once again with complaints of low back pain and wanting to return to Olympic weightlifting. The chronology of events is detailed in Figure 2. During this bout of PT, the subject presented to the clinic with a primary complaint of low back pain and occasional muscle spasms with ADL's. He still had tightness in left buttock and posterior thigh in the morning and occasionally would get tingling in the posterior thigh but the sensation did not go past the knee. The subject also reported having a fear of flexion and verbalized avoidant behavior by saying "I am scared to bend forward or go back to Olympic weightlifting because I will hurt myself again". He informed the treating physical therapist about his goals to return to Olympic weightlifting after reading online forums written by subjects with similar surgeries returning to higher-level activities. His pain intensity at rest was 2/10 and increased to 6/10 with flexion-based activities like child's pose or picking up an item off the ground like a sock. Due to his fear of flexion, his exercise routine consisted of cardiovascular exercises with a heart rate target of 150 beats per minute during box jumps and battle ropes and callisthenic strength training exercises due to fear of lifting weights.

Due to the subject's subjective reports of fear he was given a Fear Avoidance Beliefs Questionnaire – Physical Activity subscale (FABQ-PA) and a Tampa Scale of Kinesiophobia (TSK) outcome measures. These measures were utilized because the FABQ seems to be the best option to measure fear-avoidance beliefs and the TSK is best when assessing kinesiophobia.[19] The raw subject score on the FABQ-PA was 22 and 51 on TSK suggesting moderate to high levels of fear and kinesiophobia. A score greater than 15 on the FABQ-PA is considered high, and the maximum score on the TSK is a 68, with higher scores suggesting greater amounts of fear of movement.[19]

## CLINICAL IMPRESSION #1

Due to the subjects heightened fear of flexion-based activities, the subject was an appropriate candidate for PNE and graded exposure techniques due to his chronicity of symptoms and clear impact of psychosocial factors on his physical function. The delivery of PNE has been shown to lead to an immediate improvement of lumbar flexion in subjects with chronic low back pain. [20,21] In addition, when subjects with long standing pain perseverate on that pain, it can heighten fear of movement and intensify pain;[22,23] therefore, giving the subject strategies to focus less on the symptoms and more on functional tasks can decrease fear and pain. A strong relationship exists between elevated fear-avoidance beliefs and chronic disability secondary to low back pain.[13] Rather than receiving PNE prior to and immediately after the surgery the subject received information that could have encouraged fear-avoidant behavior, kinesiophobia, and decreased satisfaction with PT.[13,24]

## EXAMINATION

After the subjective history was taken, active lumbar range of motion was assessed. When asked to touch his toes during the lumbar flexion range of motion examination, the subject maintained a neutral spine and hinged at the hips due to fear of flexing at his low back (Figure 3a). The severe limitation in lumbar flexion with a fear-induced hip hinge rather than a lumbar lordosis reversal gave further evidence that PNE and flexion based graded exposure exercises would be recommended (Figure 3b). Further examination revealed tenderness to palpation in the left lumbar paraspinals, and concordant buttock pain was reproduced with passive straight leg raise at 90 degrees. The subject presented with no myotomal weakness or dermatomal irregularities and his reflexes were all normal. There was a conscious effort to emphasize the subject's positive attributes identified from the examination rather than his impairments due to

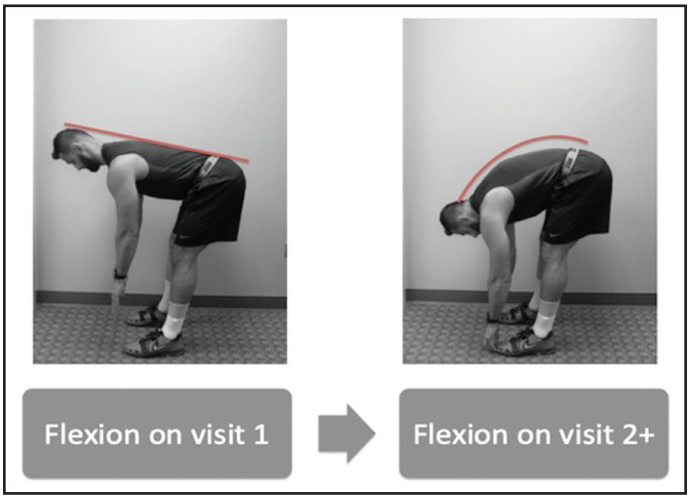


**Figure 3.** *Lumbar flexion range of motion evaluation 3a) When asked to touch his toes during the lumbar flexion range of motion examination, the subject maintained a neutral spine and hinged at the hips due to fear of flexing at his low back. The severe limitation in lumbar flexion with a fear-induced hip hinge rather than a lumbar lordosis reversal gave further evidence that PNE and flexion based graded exposure exercises would be recommended. 3b) With encouragement from the physical therapist that no damage would occur to the low back with flexion, he was able to flex at lumbar spine with normal reversal of lordosis.*

the subject's fear avoidant behavior. An exhaustive pathoanatomical PT examination was not indicated, and perhaps could have been counterproductive due to the potential of increasing subject's heightened fear of movement. Since the subject was fearful, the physical therapist chose a movement-based assessment to guide his treatment. The physical therapist interpretation was that the primary pathology had been surgically resolved, and that the patient would reach and optimal outcome with treating the movement dysfunction and implementing PNE. The subject displayed fear related symptoms with a bias towards centrally mediated symptoms rather than nociceptive. Subjects with chronic pain tend to have maladaptive beliefs about their lower back being weak and fragile[10] and it was the therapists assessment that finding more impairments may propagate those beliefs. In some cases, a thorough examination can instill confidence in a subject, however the clinician's intuition of the subject's fear, behavior and personality dictated a less exhaustive examination on day one. The PT examination focused on identifying fear avoidant movements (i.e. lumbar flexion), the reasons for fearful movements (i.e. surgeon post-operative educational intervention), and the inappropriate subject beliefs of his pain (i.e. flexion would damage his back). The subject exhibited the greatest fear of the following activities: 1) Any/all lumbar flexion activities 2) Barbell squatting and deadlifting 3) Olympic lifts such as the clean, jerk and snatch. Kingma et al. demonstrated that there can be as much as 50° of lumbar flexion during a functional squat as used in activities of daily living.[25] In addition, Hsieh et al. demonstrated that 90% of lumbar flexion was required to put on socks.[26] In order to differentiate between fear-avoidant behaviors and true physiological limitations of flexion, the subject demonstrated full range of motion during a deep bodyweight squat and the ability to put on his socks which revealed his ability to effectively flex at the lumbar spine.[25–27] This further strengthened the therapist's belief that fear-avoidance was the main cause of the subject's limitations.

## PLAN OF CARE

Based on the subjective and objective examination the subject is appropriate for the implementation of graded exposure as described by George and Zeppieri.[1] The initial session was spent identifying the most feared activities so they could be addressed in a graded manner throughout the plan of care. The subjective reports and physical examination successfully identified the subject's inappropriate beliefs that bending at the lumbar spine would cause damage. Further, the scores on the FABQ and TSK revealed moderate to high fear of movement and kinesiophobia. Since one of the subject's most feared and aberrant motions was with active lumbar flexion in standing, the decision was made to incorporate PNE with graded exposure to lumbar flexion exercises. The decision-making model is highlighted in Figure 4. The subject was first exposed to activities requiring trunk and lumbar spine flexion such as tying his shoes and picking up groceries in order to reduce disability in his day-to-day life. Along with addressing the subject's kinesiophobia, there would be a need for education on proper technique during completion of barbell exercises to help reduce unnecessary load on the lumbar spine and maximize safety. The subject has already described performing 36" box jumps as part of his workout regimen, which

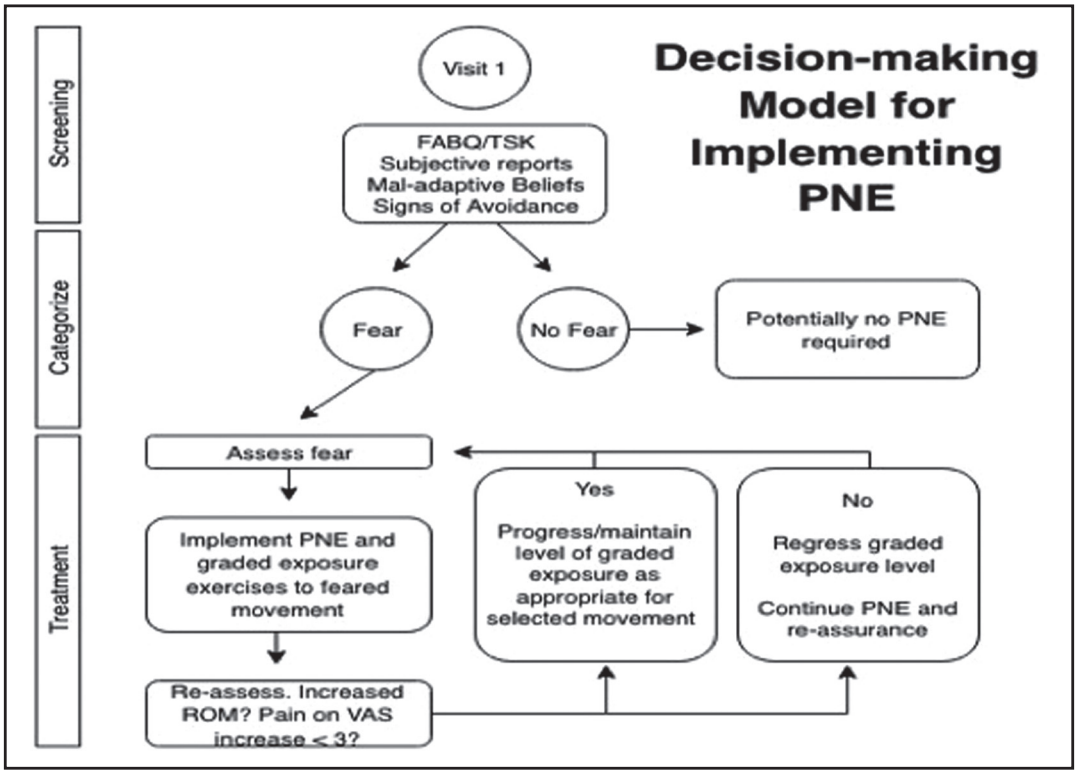


**Figure 4.** *The decision-making model used to identify fear-avoidant behavior and kinesiophobia and how to implement PNE and graded exposure on subsequent visits. Fear is assessed during treatment by identifying feared movements via subjective reports and correlating them with previously completed outcome measures. FABQ = Fear Avoidance Behavior Questionnaire. TSK = Tampa Scale of Kinesiophobia. PNE = Pain Neuroscience Education. ROM = Range Of Motion. VAS = Visual Analogue Scale.*

requires absorbing high loads through the lumbar spine and going into a deep squat and nearly full lumbar flexion,[25,27] with no symptoms. Bringing facts such as these to the attention of the subject could serve as an educational tool to help decrease fear and facilitate their understanding of pain by asking the following: "Why do you think you can perform this high-level activity that required nearly full lumbar flexion but cannot touch your toes while bending at the lower back?" The initial PT sessions were scheduled for once a week with a focus on PNE and graded exposure to flexion activities in order to help improve lumbar range of motion, decrease fear, and improve strength to allow a full return to Olympic weightlifting.

## INTERVENTION

### Visit One: Initial Interventions

As previously mentioned, a detailed examination was not performed, rather a movement-based examination with assessment of the subject's understanding of pain and fear of movement on this first visit. The subject was assigned to the Movement Control category as described in the revised Treatment-Based Classification System for low back pain.[28] Initial interventions were aimed at subject education, symptom control and improving lumbar flexion range of motion. The aberrant lumbar flexion range of motion observed during examination (Figure 3a) was corrected within the session (Figure 3b) with encouragement from the physical therapist that no damage would occur to the low back with flexion.

The subject was educated that it was okay to flex at the low back to touch his toes. He was informed that it was normal to feel stretch or discomfort in the tissues that have not moved in that direction in a while and that it was "OK" to gently push through it. Education was also given to stop the exercises if his distal pain increased. The subject was asked if he had been performing sit to stand transfers and picking items up off the floor regularly which he confirmed. Education was then provided on the fact that 95%

of maximal lumbar flexion occurs with sit to stand transfers so he had been performing a flexion-based movement since the surgery and it had not harmed him.[26] Additionally, picking objects off of the floor requires high amounts of lumbar flexion whether he bent forward or squatted to perform the activity.[29] At this point, the reasoning behind the education was to reduce the subject's fear to allow him to see that he had already been performing the movement he is so fearful of.

In addition to the education he was taken through two sets of 10 of supine double knees to chest of gradually increasing intensity in order to induce lumbar flexion movement in a manner that would not cause him to guard or be fearful, before re-assessing standing lumbar flexion. Upon reassessment of active lumbar flexion in standing, his range of motion improved from moderately limited to minimally limited, but he still felt concordant symptoms in back and thigh. Graded exposure to flexion-based exercises was initiated this visit, specifically supine single and double knees to chest. Instruction was given to perform these exercises five times per day.

**Visits Two to Five**

These visits occurred the following three weeks after the initial examination. After performing repeated supine lumbar flexion exercises for one week he demonstrated full active lumbar flexion in standing. He also reported a decrease in radicular symptoms with abolishment of tingling and a reduced intensity of buttock pain. Lastly, he reported that he had no fear of flexion during day-to-day activities such as tying his shoes, putting on pants, or lifting groceries from the floor. Due to this, it was decided that further graded exposure was not necessary for ADL's.

During visits two through five, the subject was gradually progressed toward weighted squats as shown in Figure 5 using the graded exposure model described in Figure 4. Prior to attempting a weighted squat, the subject was also instructed by the physical therapist: "You can't avoid flexion even when you try to keep a neutral spine during a squat. So you've been flexing for a while now."[27] This was said in order to build upon the idea that he has already been flexing (during sit to stands and box jumps) in order to reduce any fear prior to the weighted squat.

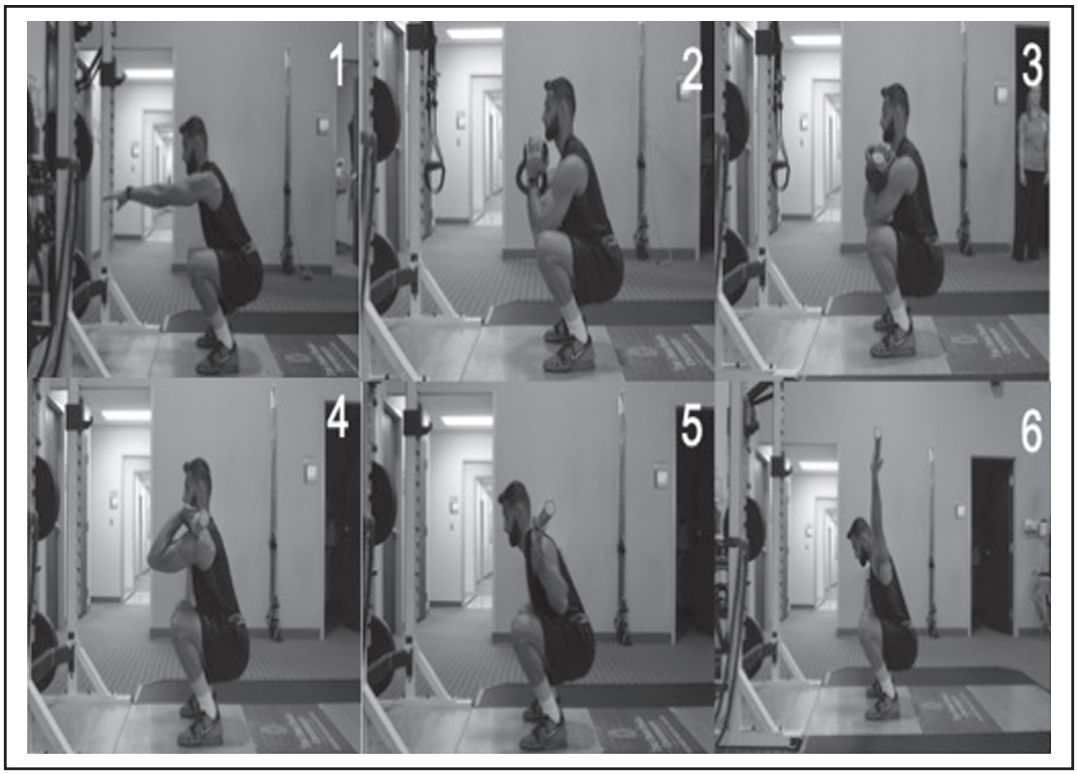


**Figure 5.** *Progression of exercises prepare for graded exposure to the overhead squat. 1) Squat. 2) Kettlebell squat. 3) Double front rack kettlebell squat. 4) Barbell front squat. 5) Barbell back squat. 6) Overhead squat.*

It was a goal of the patient to return to various resistance training exercises. Due to the decreased radicular symptoms and resolution of lumbar range of motion, resistance training exercises that the patient deemed important were resumed. For the PNE during these visits, the choice was made to integrate it gradually during the cueing and practice of Olympic weightlifting techniques. A clear subject-led decision-making model was stressed to allow the subject to build self-efficacy. During these visits, the subject revealed he had not deadlifted in 2.5 years and stopped performing barbell snatches due to the surgery. It was important to the subject to return to deadlifting and barbell snatch. A barbell snatch is an Olympic weightlifting movement where the barbell is moved from the floor to an overhead position in one motion. Based on the model of George and Zeppieri,[1] in order to return the subject to performing a deadlift, graded exposure exercises were progressed from active range motion exercises, to a Olympic weightlifting specific graded exposure model created by the authors (Figure 6) based on graded exposure and pain science.[1,30]

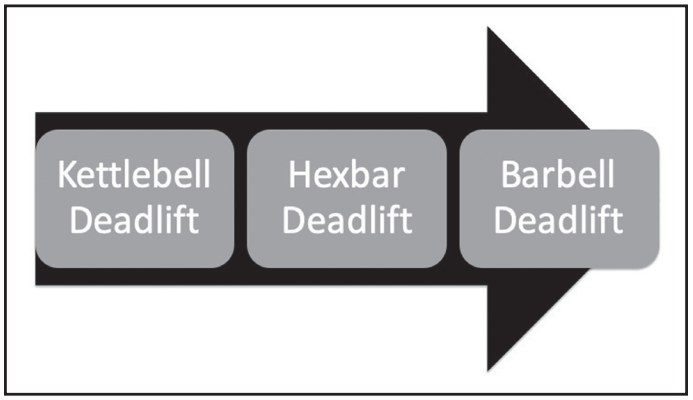


**Figure 6.** *Outlined is the pathway taken to allow graded exposure towards the barbell deadlift. Regardless of load variations, bringing the load closer to the floor is another way to progress towards a conventional barbell deadlift.*

The deadlifting progression model consists of three different exercises with progressions based on the height of the load off of the floor with the goal of safely increasing force on the spine while decreasing fear and threat of the activity. Table 1 outlines the cues given during each session to improve efficiency and technique with each lift and the rationale behind each cue. The subject was able to progress to the barbell deadlift off of the floor during visit two after encouragement from the physical therapist and technique alteration. Technique alteration included changes to the bar path and spinal and lower limb kinematics. During technique changes there was a conscious effort to place emphasis on performance (ex. Bar path efficiency, weight lifted, etc.) instead of reducing spinal loads as a way to not increase fear of load (meaning the estimated amount of spinal forces during an exercise).

During the third visit, the subject reported his goal of being able to perform the barbell overhead press and hang cleans. Since these movements require different coordination of movement and loads on the spine, it was important for the subject to master the squat and deadlift progression prior to initiating overhead press and hang cleans. The cues given during the overhead press to improve performance and

**Table 1.** *Word and Phrase Alternatives to Use for Decreased Fear and Threat in a Weightlifting Athlete.*

| Patient Education Which Caused Fear of Movement | Alternatives |
|---|---|
| Do not flex your spine after surgery. | After surgery we want you to protect your spine to allow adequate tissue healing, but eventually we want you to regain lumbar flexion. |
| Do not return to weightlifting ever again. | 81% of professional athletes return to play after this surgery.[33] With education and safe lifting practices, you'll be able to return to lifting as well. |
| You may damage your spine by flexing. | You can't avoid flexion even when you try to keep a neutral spine during a functional squat during activities of daily living.[32] So you've been flexing for a while now." |

reduce lumbar loads are described in Table 2. The subject was able to gradually progress to overhead squatting (Figure 5) and barbell push snatch during this session so they were integrated at light weights as the subject's warm-ups to help decrease the threat of these advanced movements. The subject was educated on the performance of a proper bracing sequence (Figure 7) in order to increase intra-abdominal pressure during lifting exercises. There is some evidence that fear of movement is related to increased trunk stiffness or muscle activity in subjects with low back pain so the bracing technique was only incorporated during lifting of heavier loads in order to avoid feeding into the subject's fear that movement is harmful during daily tasks.[31–33] The bracing technique was also implemented to avoid overreliance on lumbar spine erector spinae to provide spinal stability due to the subject's complaints of lumbar tightness and spasms. This technique allowed the subject to perform the barbell overhead press and the barbell back squat without increased lower back tightness.

**Table 2.** *Cues to improve performance and reduce lumbar spine loads during lifts.*

| Lift | Performance Cue | Rationale for Cue |
|---|---|---|
| Deadlift | • Start with hips higher<br>• Hips through the bar | • A common modification LBP patients will make is trying to squat the bar rather than hip hinge<br>• In order to decrease the amount of lumbar extension at the top of the deadlift and reinforce terminal hip extension |
| Front Squat | • Uncurl fingers from around bar | • Fingers curled around the bar without adequate wrist extension will pull the bar anteriorly and cause excessive forward torso lean and elbows to drop |
| Back Squat | • Squat down, not back<br>• Slight butt squeeze and exhale before descending | • Encourages more upright torso and spinal stability<br>• Allows lifter to achieve a neutral spine posture and decreases lumbar extension throughout the lift |
| Strict Overhead Press | • Butt squeezed<br>• Elbows under the bar<br>• Retract the chin | • Encourages avoidance of excessive lumbar extension and increases stability<br>• Encourages the lifter to keep the bar over the COM<br>• Decreases likelihood of excessive lumbar extension in order to allow bar to pass by the chin |


**Figure 7.** *Bracing sequence before performing a weighted barbell movement. Patient is first instructed to exhale in order to depress ribs and then slightly posteriorly rotate the pelvis in order to allow the two structures to align vertically. Patient is then instructed to activate the lower abdominals and the breathe into the active tension created.*

During visits four and five, the main focus was educating the subject on the progression rules in order to make sustained gradual progress in the return to previous levels of strength.

### Rules for Progression of Lifts

Linear periodization (Figure 8) and graded exposure (Figure 4) were the main focus of education regarding how to advance strength training. These rules of progression were introduced the first visit, and emphasized each subsequent visit, so the subject could progress his exercises on his own, thus increasing his self-efficacy. Linear periodization is the most common form of periodization used in the rehabilitation setting.[34] This method of periodization was deemed appropriate due to its predictable nature and its ability to allow a step-wise progression that can be symbiotic with graded exposure. Advancement and progression of exercise in linear periodization is reliant upon the successful completion of the previous phase, which is similar to graded exposure. The predictable nature of linear periodization also allows the subject to become more independent with the performance and progression of the exercise program.

Along with linear periodization, the decision was made to implement progression based on Rating of Perceived Exertion (RPE) rather than a percentage of 1-Rep Max (1-RM). The use of RPE allows the subject or client to auto-regulate their training based on daily fluctuations of well-being and strength (Figure 9). The effective use of the RPE scale is partly dependent on the experience of the athlete[35] and the subject described in this case report had a thorough understanding of the scale through previous use.

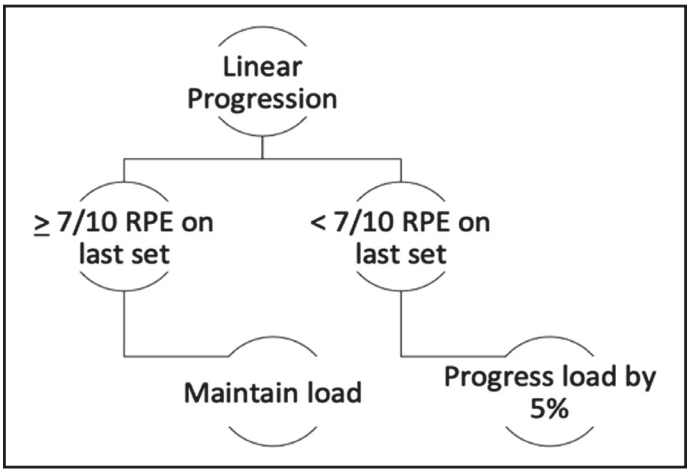


**Figure 8.** *Linear Periodization Model that was used with the patient in the case. RPE is described in Figure 9. Load is defined by the weight lifted during the exercise.*

| Rating | Description of Perceived Exertion |
|---|---|
| 10 | Maximum effort |
| 9.5 | No further repetitions but could increase load |
| 9 | 1 repetition remaining |
| 8.5 | 1-2 repetitions remaining |
| 8 | 2 repetitions remaining |
| 7.5 | 2-3 repetitions remaining |
| 7 | 3 repetitions remaining |
| 5-6 | 4-6 repetitions remaining |
| 3-4 | Light effort |
| 1-2 | Little to no effort |

**Figure 9.** *Resistance exercise-specific Rating of Perceived Exertion (RPE).*

## OUTCOMES

Objectively, the subject demonstrated full active lumbar flexion and had no hesitation with performing ADL's requiring lumbar flexion like picking objects off the floor or tying his shoes. The subject was able to make a full return to all Olympic weightlifting movements with the potential to progress toward previous levels of strength. His FABQ-PA score decreased from 22 to 4 and his TSK score from 55 to 31 demonstrating a clear reduction in movement-related fear. On the FABQ-PA, the minimal detectable change is 5.4 points, and a decrease in TSK score is suggestive of reduced fear in movement.[37–39] The scores on the FABQ-PA and TSK suggest that a combination of a movement based assessment and treatment with PNE led to a significant reduction in fear avoidance and kinesiophobia. The subject also reported subjective reductions in fear with all movements and Olympic weightlifting activities.

## DISCUSSION

The current literature on the use of PNE in high-level athletes, such as weightlifters, is scarce. The incidence of fear-avoidant behaviors in weightlifters after lumbar surgery has not been studied.

The subject arrived at his second bout of PT with high fear-related movement restrictions including limited flexion mobility throughout his lumbar spine. When the surgeon discharged the subject, per subject report, the surgeon educated him to never again lift weights (Olympic weight lifting) or bend forward. This appears to have been an integral moment in the subject's development of fear-avoidant behavior after the surgery. The surgeon may have been accurate with such imposed restrictions in the immediate post-operative time frame; however, this may have led to increased kinesiophobia in the long-term following surgery. Healthcare providers can negatively impact subjects pain and function by their words and education, thereby increasing kinseiophobia.[24] This case emphasizes the importance of patient education as it relates to post-surgical precautions, timeframes for such precautions, and rehabilitation. Although it may have not been the intention of the healthcare provider, it is possible that such comments triggered kinesiophobia in the subject with the words that were used (Table 1).

There is a paucity of evidence in the application of PNE to return an athlete with lower back pain to Olympic weightlifting. Although graded exposure is part of the PNE model, the authors felt it important to highlight these components separately in order to demonstrate how the verbal education and graded exposure to specific, targeted exercise and movement were both integrated into treatment for an Olympic lifting athlete. Additionally, to the authors' knowledge there is a lack of evidence for the use of PNE after lumbar discectomy. The lumbar discectomy is the most common procedure performed in the United States for subjects with back and leg pain.[40] In 2003, 2.1 per 1000 Medicare recipients received a lumbar discectomy/laminectomy in order to treat their lower back pain and other associated symptoms.[40] Reoperation rates have been reported at approximately 12-14% after single-level lumbar discectomy leading to increased healthcare costs.[41] Roughly 15-25% of subjects that receive lumbar discectomies have recurrent lower back and leg symptoms when followed for 2 years.[40] PNE is a viable, affordable option pre- and post-lumbar discectomy that can lead to optimal outcomes and reduced spending.[3]

The implementation of PNE into clinical practice may lead to optimal outcomes after surgery, reduced kinesiophobia, reduced pharmaceutical use, and decreased cost of care. Pre-operative PNE has been utilized for subjects undergoing lumbar discectomy and has led to reduced healthcare costs, pain, and disability.[13] In addition to PNE, the integration of graded exposure into the treatment of musculoskeletal pain has been beneficial in the geriatric population with lower back pain.[15] Graded exposure allows the subject to confront specific situations they may be fearful of in a gradual and non-threatening manner allowing a decrease in fear-avoidant behaviors. The available literature supports the use of graded exposure in subjects with chronic low back pain, but little is known about the use of PNE after discemtomy.[1]

Shifting the focus of technique alterations from reducing loads or preventing injury to the ability to improve performance is an important strategy to reduce fear and affect the attention component of pain.[22,23] The subject's base strength was sufficient for performing ADLs and movements such as lunges, box jumps, and leg press as evidenced by his performance of those movements. His primary issue however, was his fear of flexion-based loading. Thus, reframing the construct of spinal flexion and associating it with tasks that he had already been performing to an adequate level was key in allowing the subject to return to flexion type activities gradually. The subject was able to return to Olympic weightlifting activities within four weeks of starting his second bout of physical therapy with PNE and graded exposure indicating further his main limiting factor was his fear of movement and belief of flexion activities causing damage to his back. Additionally, this subject demonstrated a significant improvement in not only his FABQ and TSK scores[42,43] but also in his performance of various Olympic weightlifting exercises. The FABQ-PA has been shown to have a ceiling effect which could explain why that outcome measure showed a greater decrease in score than the TSK.[44,45] Both measures were used because as of right now the FABQ seems to be the best option to measure fear-avoidance beliefs and the TSK is best when assessing kinesiophobia.[19]

There are limitations to this case report worth noting. This case described the experience of one individual

and results may not be generalizable to others. Additionally, another weight lifter post lumbar surgery could respond differently to interventions delineated in this report, therefore caution should be utilized. The case report included the use of the RPE scale that depends on the subject's experience.[35] The experience and comfort of a subject using the RPE scale reduces the applicability of the progression method with subjects that have less experience with lifting weights. Although, using RPE has been shown to be a reliable and valid measure of exercise intensity as it correlates with one-repetition maximum.[46] Also, the therapeutic alliance developed between the physical therapists and the subject cannot be understated. Therapeutic alliance has been shown to enhance outcomes in subjects that may be encountered in PT clinics.[47] This was cultivated through the physical therapist's knowledge of movement assessment and Olympic weightlifting, however it was not formally assessed in this case report. In the authors opinion, having a physical therapist with a thorough understanding of barbell kinematics and lifting techniques was integral in achieving subject buy-in and enhancing the outcome. Future research should examine the effects of PNE and graded exposure on other athletes after injury and surgery.

## CONCLUSIONS

This case report outlines methods including PNE and graded exposure (using periodization principles) that effectively reduced kinesiophobia and fear avoidance in a weight lifter who was post-lumbar discectomy. These interventions allowed him to meet his goal of returning to performing Olympic style weight lifting. Healthcare providers need to understand that the words they use to communicate with subjects can have lasting positive or negative effects. PNE is an intervention that can be used with and adapted to the needs of a higher-level athlete. Understanding the biopsychosocial contributors to a person's movement restrictions can help direct the treatment towards the main limiting factor in order to improve outcomes.

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